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A NOVEL JOINT DATA-HIDING AND COMPRESSION SCHEME BASED ON SVD AND DWT

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ABSTRACT

Data hiding is becoming a major necessity for preventing media misuse. To secure or prevent the data theft watermarking is being implemented in the images or videos. The data hiding may be invisible or visible. Even the methods for watermarking are being developed in rapid but the watermark hided is unstable when the cover image is being put into transformation. In literature many watermarking schemes are proposed which are resistable for alterations are suggested in which different methods run to avoid the loss of data during compression of watermarked image. SMVQ and inpainting along wavelets are used for the data hiding parallel with compression, but in compactable to the colour images which is major drawback. To resolve the media misuse problem novel method is proposed for colour image, proposal of an effective, robust and imperceptible colour image watermarking scheme. The three components Red, Green, Blue of (RGB) space are utilized by this scheme to embed watermark into the coverimage. Specifically the combinations of Discrete Wavelet Transformation (DWT) and Singular Value Decomposition (SVD) of Blue channel are used to embed the watermark. The singular values of wavelet subband coefficients of Blue channel are use in different scaling factors to embed the singular values of the watermark. Four subband coefficients are utilized for embedding the copy of the watermark, which is very difficult to remove or destroy. The combination of DWT and SVD increases the security, robustness and imperceptibility of the scheme.

KEYWORDS: ***Data Hiding, Lossless Compression, Discrete Wavelet Transformation (DWT), Singular Value Decomposition (SVD), Lossless Reconstruction, Complex Blocks***

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INTRODUCTION

Data hiding involves embedding significant data into various forms of digital media such as text, audio, image and video secretly. Applications of data hiding are copyright protection, fingerprinting and secret communication. The purpose of data hiding techniques is different from that of traditional cryptography or watermarking techniques. Traditional Cryptography encrypts messages into meaningless data while watermarking is utilized to protect the copyright. Data hiding technique covers the secret information with the host media as camouflage and is considered as an extension of traditional cryptography.

Because of rapid advances in the Internet technology anyone can transmit the data and share digital (images, video) content with each other conveniently and it is widely used & accepted. For guaranteed communication (through internet) efficiency and save the network bandwidth, efficiency, compression techniques

can be implemented in digital components to reduce redundancy, noise and the quality of the decompression should also be preserved. The digital content like digital images and videos are transformed into the compressed format for communication. As internet is used as a medium for transmission/communication so we have to consider how to broadcast the surreptitious or confidential data firmly.

For secret communication Cryptography is one of the methodology, where encryption and decryption both steps are performed. In the encryption step the plain text is transformed into cipher text /secret message which is an encryption process performed by the sender by using an encryption algorithm. In the decryption step the cipher text is transformed into plain text which is a decryption process performed by the receiver by using a decryption algorithm. As it provides security but as some random data is utilized for the cryptography process. So there may be chance that the attacker can easily predict the secret information.

Later steganography technique was introduced as a solution. Where the aim of cryptography is to construct information illegible by attacker, whereas steganography aim is to put out of sight the data from attacker. For the reason that of the extensive usage of digital images on the Internet, so compression of images to be done and then how to hide the secret data into the compressed form of images efficiently.

To overcome the pitfalls of cryptography, information hiding techniques have been extensively developed, which can embed secret data into the cover data undetectably. Due to the predominance of digital image on the internet, how image compression to be done and then hide the secret data into the compressed images efficiently deserves in depth study.

Several data-hiding schemes for the compressed codes have been reported, these schemes are applied to a range of compression techniques of digital images, such as JPEG, JPEG2000 [3-4], and vector quantization (VQ) [6-9]. VQ is the one for the most part of accepted lossy data compression algorithms, because of its simplicity and cost effectiveness. So it is broadly used for digital image compression in implementation. Throughout the VQ compression process, the Euclidean distance is utilized to calculate the similarity between each image block and the codeword's in the codebook. In order to represent the block, the index of the codeword with the smallest distance is recorded. [1]

VQ compression codes are generated based on the index table which contains index values for all the blocks. As only the index values are stored as a substitute of pixel values. For that reason, the compression is achieved successfully. As only a simple table lookup operation is necessary for every received index. So VQ decompression method can be implemented effortlessly and proficiently.

An adaptive data hiding method is utilized for VQ compressed images which is based on amount of hidden data, so that the embedding process was varied. In this technique, the VQ codebook was partitioned into two or more sub codebooks, and the finest match in one of the sub codebooks was set up to conceal / cover secret data. VQ-based data-hiding method by a codeword clustering technique which enhances the embedding capacity. Through codeword-order-cycle permutation the secret data be embedded into the index table. With the cycle technique, more potential and elasticity can be offered to improve the performance of this scheme. For embedding secret sub message the predetermined distance threshold was accustomed according to the requisite hiding capacity and set a number of related codeword's in one group to embed the secret sub message.

In side match vector quantization (SMVQ) and image inpainting. Both functions of data hiding and image compression can be integrated into one single module seamlessly. Excluding the blocks in the leftmost and topmost of the

image at the sender side, every of the other residual blocks in raster-scanning order can be embedded with secret data and compressed concurrently / at the same time by SMVQ or image inpainting adaptively according to the current embedding bit [1].

To resolve the media misuse problem novel method is proposed for colour image, proposal of an effective, robust and imperceptible colour image watermarking scheme. The three components Red, Green, Blue of (RGB) space are utilized by this scheme to embed watermark into the cover image. Specifically the combinations of Discrete Wavelet Transformation (DWT) and Singular Value Decomposition (SVD) of Blue channel are used to embed the watermark. The singular values of wavelet subband coefficients of Blue channel are use in different scaling factors to embed the singular values of the watermark. Four subband coefficients are utilized for embedding the copy of the watermark, which is very difficult to remove or destroy. The combination of DWT and SVD increases the security, robustness and imperceptibility of the scheme.

REVIEW ON VQ & SMVQ

Hsieh and Tsai proposed search-order coding (SOC) algorithm. The VQ index table was further compressed by utilizing this SOC. So that we attained superior performance of the bit rate all the way through search the close by identical image blocks following a spiral path. A number of steganographic schemes were also projected to embed secret data into SOC compressed codes. As an enhanced version of VQ, Side match vector quantization (SMVQ) was designed in which both the codebook and the sub codebooks are used to produce the index values, not including the blocks in the leftmost column and the topmost row.

In recent times, many researchers have studied on embedding secret message by SMVQ. In 2010, Chen and Chang proposed an SMVQ-based secret-hiding scheme using adaptive index. The weighted squared Euclidean distance (WSED) was utilized to enhance the likelihood of SMVQ for a high embedding rate. In order to make the secret data undetectable to the interceptors, Shie and Jiang hided secret data into the SMVQ compressed codes of the image by using a partially sorted codebook. The re-establishment of the original SMVQ-compressed image can be achieved at the receiver side [1].

The image compression process and the data hiding process are two independent modules on the server or sender side. In this condition, the attacker may have the opportunity to interrupt/disrupt the compressed image without the watermark information embedded i.e.; the data hiding is always conducted after image compression, and the two independent modules may cause a poorer competence in applications.

Hence, one must not only focus on the high hiding capacity and recovery quality, however build a joint data-hiding and compression (JDHC) concept and integrate the data hiding and the image compression into a single module effortlessly, which can avoid the risk of the assault from interceptors and enhance the implementation efficiently. The JDHC scheme is based on SMVQ and image inpainting. In this SMVQ and image inpainting for some complex remaining blocks VQ is utilized to manage the visual distortion and error diffusion caused by the progressive compression.

Now-a-days there is call for to reduce the amount of digital information stored and transmitted is a continually rising concern. Singular Value Decomposition is a useful tool for minimizing data storage and data transfer in the digital community. In this paper image compression and data hiding is done with the use of SVD and DWT.

IMPLEMENTATION

Here the goal is to apply linear algebra “Singular Value Decomposition (SVD) “to midlevel image processing, particularly to area of image compression and recognition. The method is factoring a matrix A into three new matrices U, S, and V, wherever $A = USV^T$, Where U and V are orthogonal matrices and S is a diagonal matrix. SVD can be performed on any real (m, n) matrix. Let’s say we have a matrix A with m rows and n columns, with rank r and $r \le n \le m$.

Under dissimilar term k of singular value different experiments are conducted, and also for the outer product expansion of image matrix A for image compression, dissimilar experiments were also conducted [3].

MATLAB is used as a platform of programming. Since MATLAB is a high performance in integrating calculation, revelation and programming [3].

How to reduce the amount of data necessary to represent a digital image is nothing but an area which deals with Image compression. So Image Compression can be achieved by the removal of three basic data redundancies: 1) Coding redundancy, which is present when less than optimal; 2) Inter pixel redundancy, which results from correlations between the pixels; 3) Psycho visual redundancies, which is due to data that is ignored by the human visual [2][3].

Based on the property of SVD “the rank of matrix A is equal to the number of its nonzero singular values”. In numerous applications, the singular values of a matrix decrease quickly with increasing rank. This property allows us to diminish the noise or compress the matrix data by eliminating the small singular values or the higher ranks [3].

Whenever an image is SVD transformed, it is not compressed. The form of the data which was obtained contains a first singular value which had a great amount of the image information. Which means that using only a few singular values to represent the image with little differences from the original. To illustrate the SVD image compression process, we show detail procedures:

$$A = USV^T = \sum_{i=1}^{r} \sigma_i U_i V_i^T$$

When compression to be done for the image, then the sum is not performed to the very last SVs; the SVs with small enough values are dropped. (consider that the SVs are ordered on the diagonal) The closet matrix of rank k is obtained by truncating those sums after the first k terms:

$$A_k = \sigma_1 U_1 V_1^T + \sigma_2 U_2 V_2^T + \cdots \sigma_k U_k V_k^T$$

The total storage for k A will be k (m + n + 1). The integer k can be chosen confidently less than n, and the digital image corresponding to k A still have very close to the original image. Nevertheless, singular k will have a different equivalent image and storage for it. For typical choices of the k, the storage required for k A will be less the 20 percentage.

Based on the computed compression factor and the quality of the compressed image the performance of the SVD was determined. Image compression factor can be computed using the Compression ratio:

$C_R = m*n/(k (m + n + 1))$

To calculate the quality between original image A and the compressed image A_k, the measurement of Mean Square Error (MSE) can be computed [3] as:

$$MSE = \frac{1}{mn}\sum_{y=1}^{m}\sum_{x=1}^{n}(f_A(x,y) - f_{A_k}(x,y))$$

The process and steps followed for Encryption and decryption is explained in the following lines.

Encoding

Input: The colour image I of size m x n and the monochrome watermark W of size m/2 x n/2

Output: The watermarked colour image I' of size mxn.

- Separate Red (R), Green (G) and Blue (B) channels from the colour image I of size m x n
- Apply one-level DWT on B channel to produce the subband coefficients {LL, LH, H L, H H} of the size m/2 x n/2.
- Apply SVD on the each subband coefficients II = UISIV I to get the singular values AL i = 1,2, ..., n/2, of Sl, l E {LL,LH,HL,HH}
- Apply SVD on watermark W = UwSwVw to get the singular values f', i = 1,2, ..., n/2 of Sw
- for {LL,LH,Hl,HH} do for 1 to n/2 of $l \in \{LL, LH, HL, HH\}$,

for $i \leftarrow 1$ **to** $n/2$ **do**
$\bar{\lambda}_i^l = \lambda_i^l + \alpha\lambda_i^w;$
end

- Apply inverse SVD using the singular value i = 1,2, ..., n/2 of l= {LL,LH,HL, HH} to get modified subbands using 1'1 = Ul S' Vl.
- Apply inverse DWT on modified subband coefficients to produce the watermarked B channel.
- Transform the R, G and watermarked B channels into colour image.

Decryption

Algorithm in step wise

- The colour image I of size m x n and the monochrome watermark W of size m/2 × n/2
- Separate Red (R), Green (G) and Blue (B) channels from the colour image I of size m x n
- Apply SVD on the each subband coefficients lI = UISIV I to get the singular values AL i = 1,2, ..., n/2, of Sl, l E {LL,LH,HL,HH}
- Apply SVD on watermark W = UwSwVw to get the singular values Af', i = 1,2, ..., n/2 of Sw

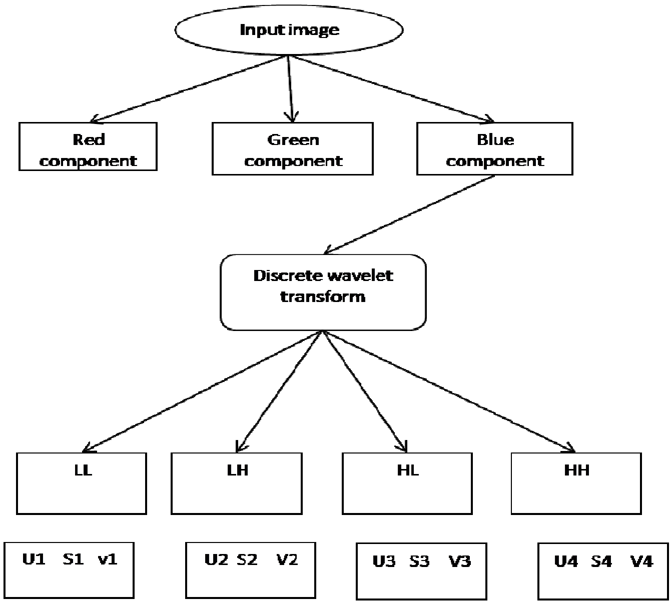

Figure 1: Image Component

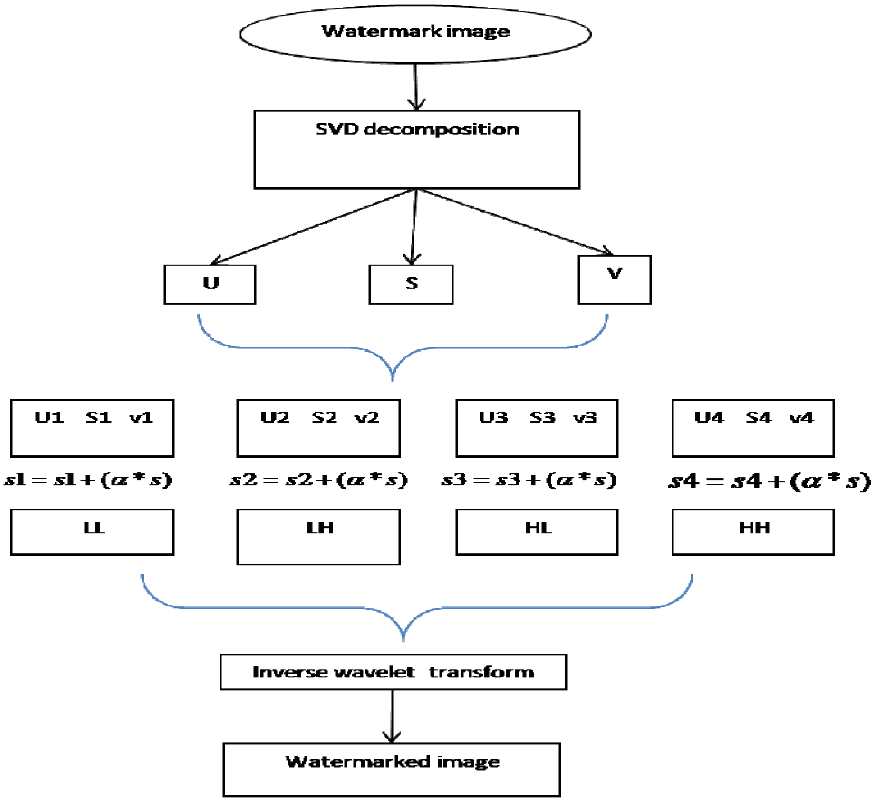

Figure 2: Compression & Watermark Insertion

RESULTS & DISCUSSIONS

SVD with the maximum energy packing property is usually used in compression. SVD decomposes a matrix into orthogonal components with which optimal sub rank approximations may be obtained [4].

Under the area of image processing many of the SVD characteristics are at a halt. The paper which was contributed in using unused SVD characteristics such as adaptive block based compression, perceptual multiple

watermarking, image capacity for hiding information, roughness measure, etc., All these contributions were experimentally examined and demonstrate probable results when compared to developed ones. The main contributions in this paper are a new prospective vision in utilizing the SVD Properties. By reviewing and experimental valuation of the developed SVD based application perceptual progressive compressions as well as perceptual progressive data hiding are attained. Image compression and encryption were methodically examined and provided good results [4].

In order to verify the effectiveness of the proposed scheme experiments were conducted on a group of color images. Color images of 256 X 256 are taken into consideration. Based on the obtained results the performances of compression ratio, decompression quality, hiding capacity and PSNR for the proposed scheme were examined. All experiments were implemented on a computer with a 3.00 GHz processor, 2.00 GB memory, and Windows 7 operating system, and the programming environment was Matlab 7.

The GUI of the implemented system where the considered cover image and the watermark image are shown in the figure 3. The watermarked blue component and watermarked image are shown in figure 4. The watermark which was extracted successfully shown in figure 5. The comparative results for improved PSNR is shown in table 1 and the graphical comparison was shown in figure 6.

Experimental results showcasing that the proposed methodology is a recognized and effective method to divide the system into a set of linearly independent components, every one of them is carrying own data to donate to the system. It has the advantage of providing a good compression ratio, and that can be well adapted to the statistical variation of the image; The drawback is that it is not fast from the computational point of view, and the problem of which its application is strongly conditional due to the excessive work of associate calculations [3].

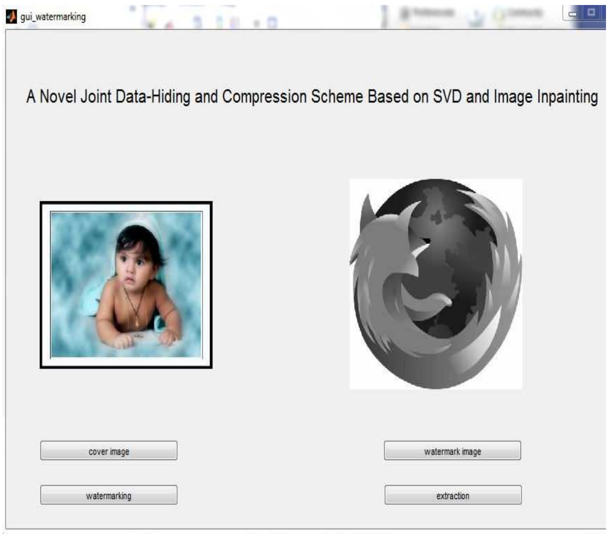

Figure 3: GUI of the Implemented System

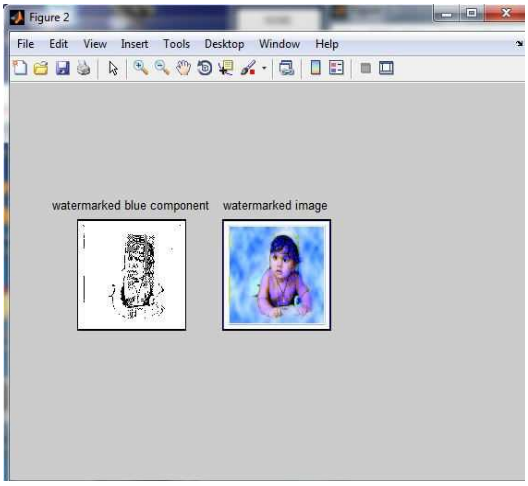

Figure 4 Watermarked Image

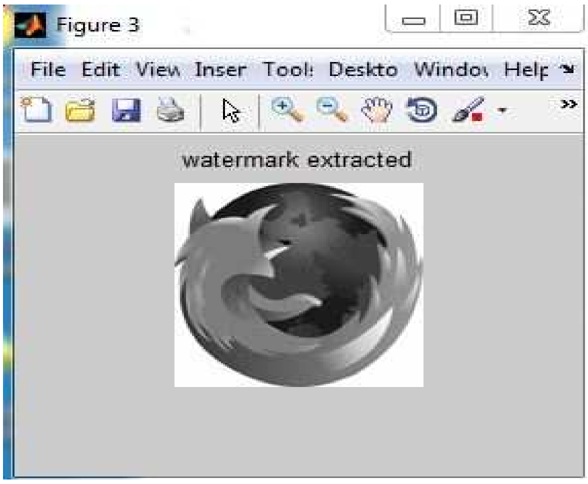

Figure 5: Extracted Watermark at the Receiver

Table 1: PSNR Comparison for SMVQ and SVD Compression Methods

Image Number	Image/Method	PSNR	
		SMVQ	SVD
1	Baby girl	09.7085	39.6265
2	Beautiful bird	13.9722	40.2442
3	Firefox logo	10.9769	39.0538

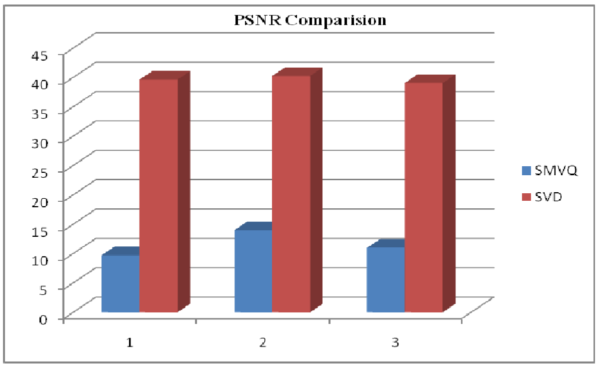

Figure 6 PSNR Graphical Comparison

CONCLUSIONS

The result obtained for image compressing has satisfactory of image compression ratio compared with image quality. This scheme can be implemented and used in Military applications for sending secret data using watermarking. This is a novel encryption method which is used in NASA applications too.

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